

Very Preliminary Cost Estimates for LB DUSEL Neutrino Beam

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Fermilab

October 15, 2008

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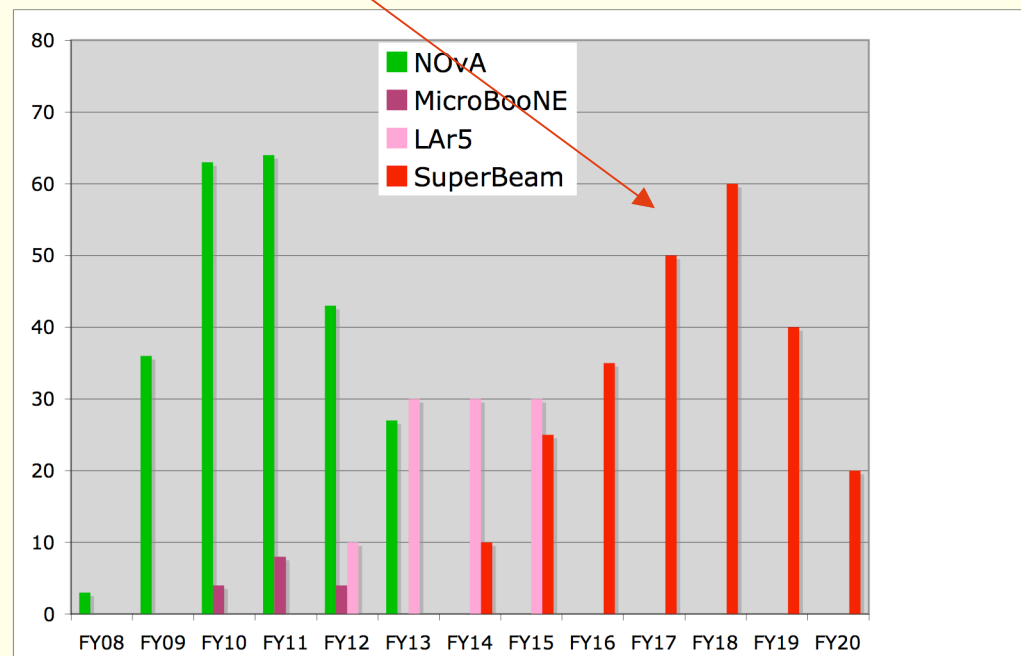
- Disclaimers
- Review of NuMI beam project scope and actual costs
- Methodology for estimating cost of a **new beam project**
- Issues to be resolved
- Next steps
- Comments on schedule
- Backup Material

- Disclaimers

- This material has been prepared for preliminary discussions only. It has not been vetted by technical experts or Laboratory management.
 - It's just to get an idea of how much this project *might* cost
- There is a lot more work needed to be done!
- The Laboratory is currently preparing cost estimates for Project X and Mu2e as well as LBDUSEL. We plan to come up with a set of standard numbers for inflation, SWF and overhead rates that will be applied uniformly to all projects, but has not been implemented yet.
- I have worked under an assumption that the beam to DUSEL would not be “needed” until ~2021 (after completion of delivery of beam to the NuMI-NOvA experiment)
 - If this assumption were no longer valid the funding profile could change

January 2008 (P5) “cost estimate”

- Took NuMI TEC of \$108M
- Multiplied by 1.5 for complexity
- Multiplied by 1.5 for inflation from FY98 to FY09 (11 years at 3.5%)
- → TEC of ~\$240M



What's needed to get this
“right”?

- Depends on how soon we need it.
- To get it “right” takes real design work in many areas → many person-years of effort.
- At this time we have ~ 0 FTE’s available to do *design work*.
 - DUSEL Beam Working Group is collecting “lessons learned” from NuMI (See J. Apple talk tomorrow)
 - Fermilab manpower *is* working on
 - ANU
 - Project X
 - Mu2e
- We need to get an answer without using resources....

Methodology : Civil Construction

1. Start with NuMI actual for WBS 1.2.3.4-7 (fully burdened - includes overhead)
2. Apply escalation
 1. NuMI AY\$ to FY09\$
 2. FY09\$ to FeHo TY\$
3. Add 25% for EDIA
 1. Do CDR, Title I and Title II : 2009 - 2013
 2. Begin construction in 2014
4. Complete major construction in 2019
5. Tie into NuMI extraction line 2020 - 2021
6. Apply 50% contingency

Methodology : Technical Components

1. Start with NuMI actuals (fully burdened - include overhead and EDIA)

1. Treat SWF and M&S separately

2. Apply complexity factor for each

This is what's different from the civil.

3. Schedule considerations

1. CDR development (2010 - 2013)
 2. TDR level work begins in 2014
 3. installation complete in 2021

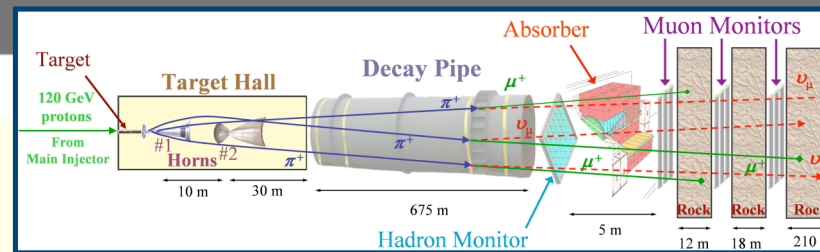
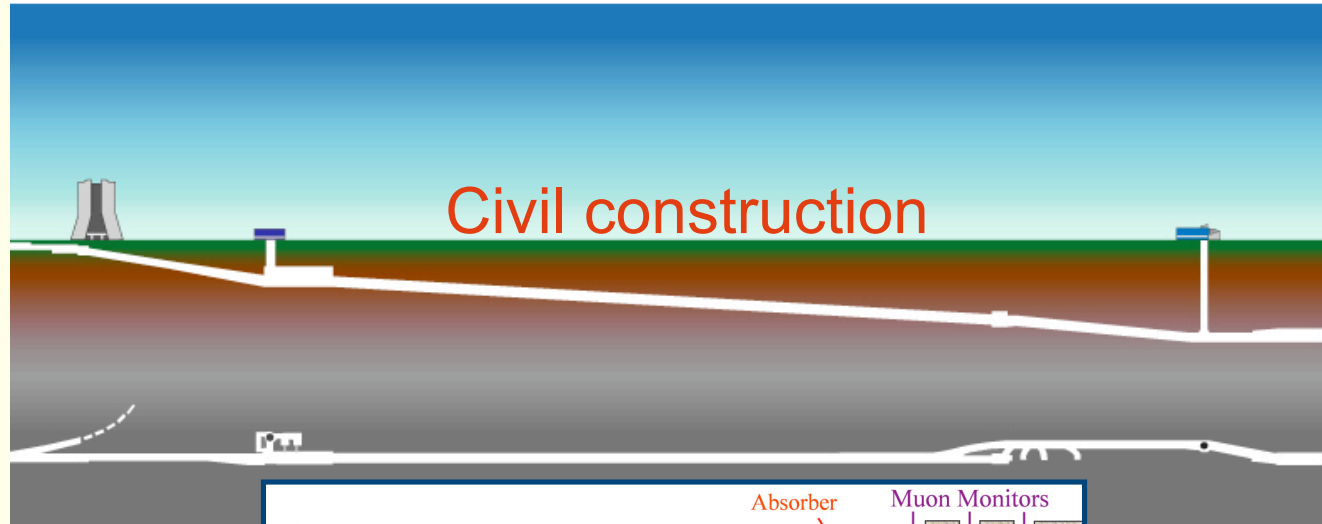
Based on manpower availability and NOvA schedule

4. Apply escalation

1. NuMI AY\$ to FY09\$
 2. FY09\$ to FeHo TY\$

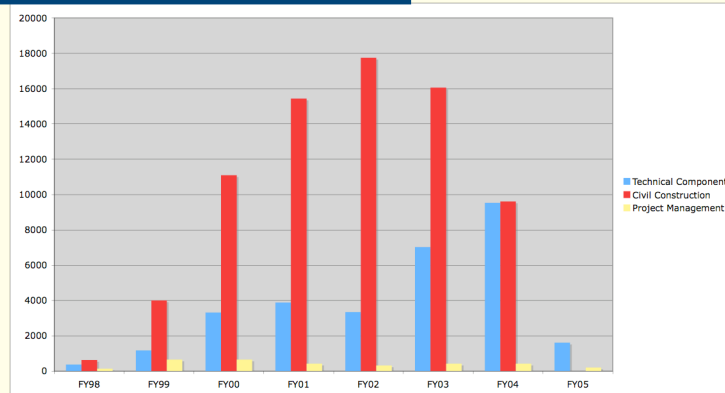
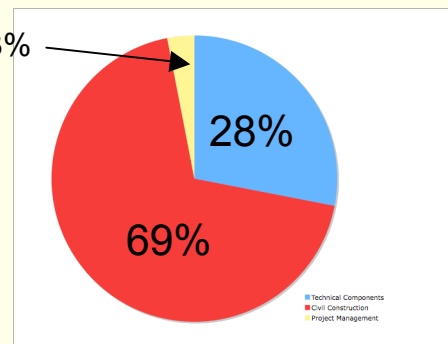
5. Apply 50% contingency

The NuMI Project



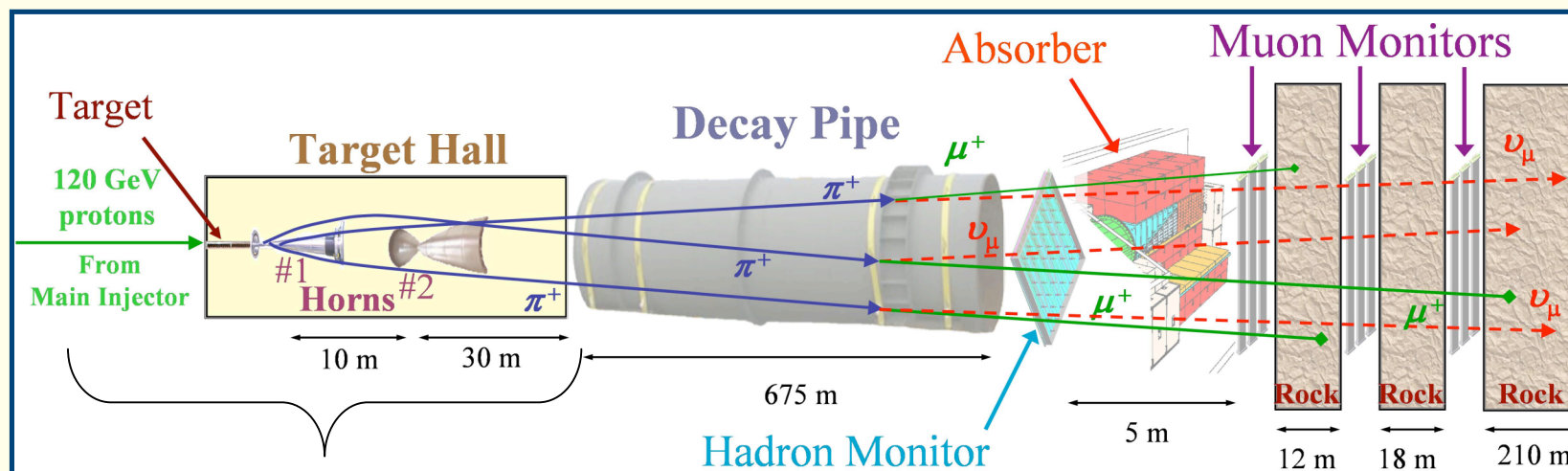
Technical Components

Project Management 3%



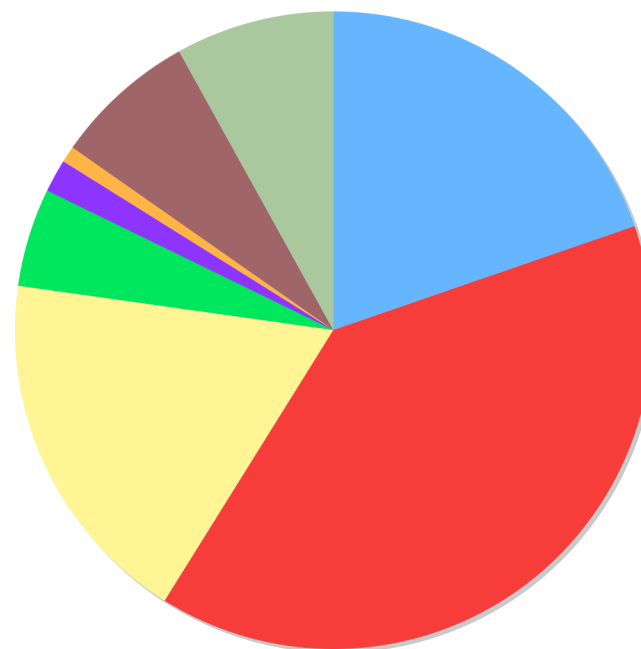
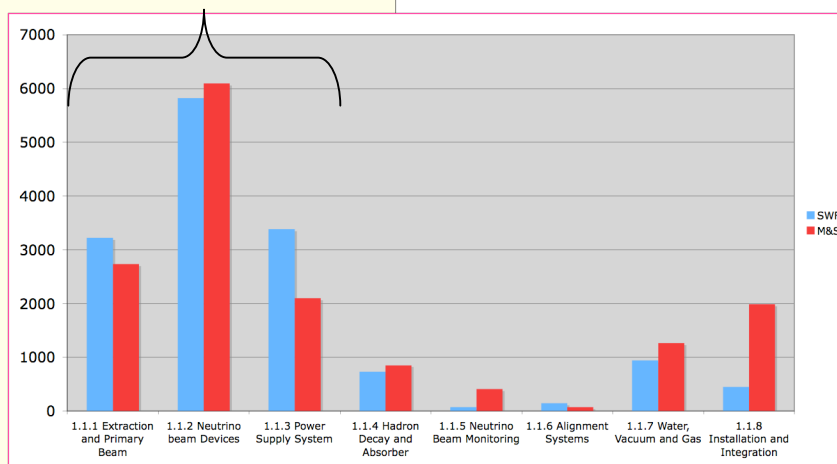
WBS		FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	Total
1.1	Technical Components	370	1182	3324	3895	3351	7024	9539	1617	30302
1.2	Civil Construction	628	4009	11095	15434	17751	16057	9611	0	74585
1.3	Project Management	141	656	663	423	324	421	430	203	3261
	Total	1139	5847	15082	19752	21426	23502	19580	1820	108148

NuMI Technical Components

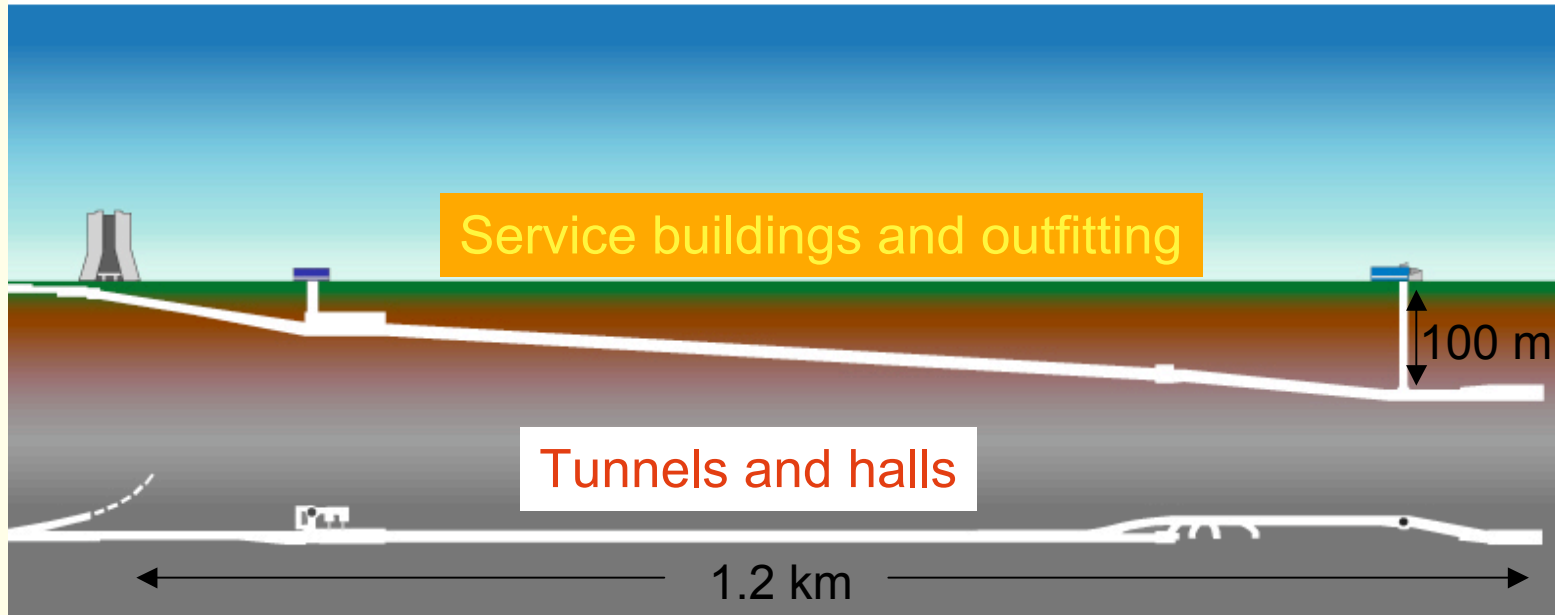


Cost drivers

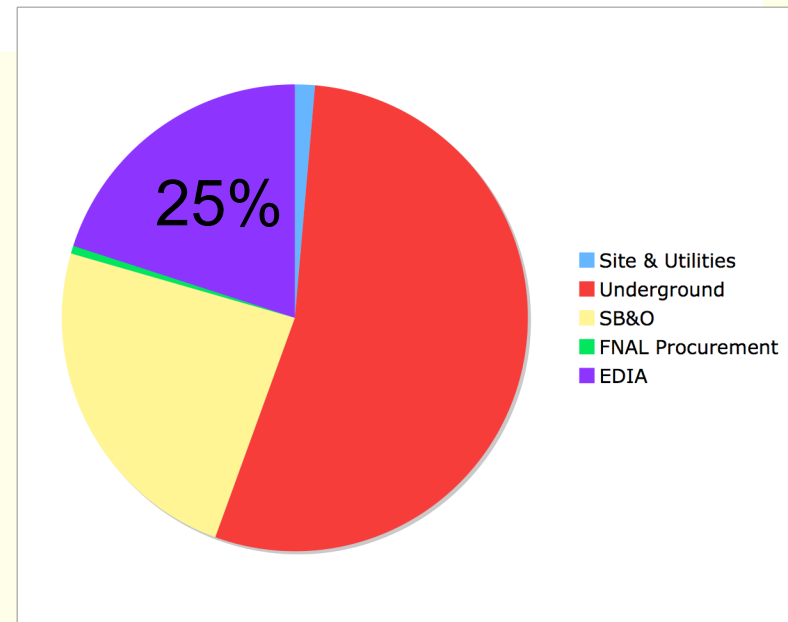
- 1.1.1 Extraction and Primary Beam
- 1.1.2 Neutrino beam Devices
- 1.1.3 Power Supply System
- 1.1.4 Hadron Decay and Absorber
- 1.1.5 Neutrino Beam Monitoring
- 1.1.6 Alignment Systems
- 1.1.7 Water, Vacuum and Gas
- 1.1.8 Installation and Integration



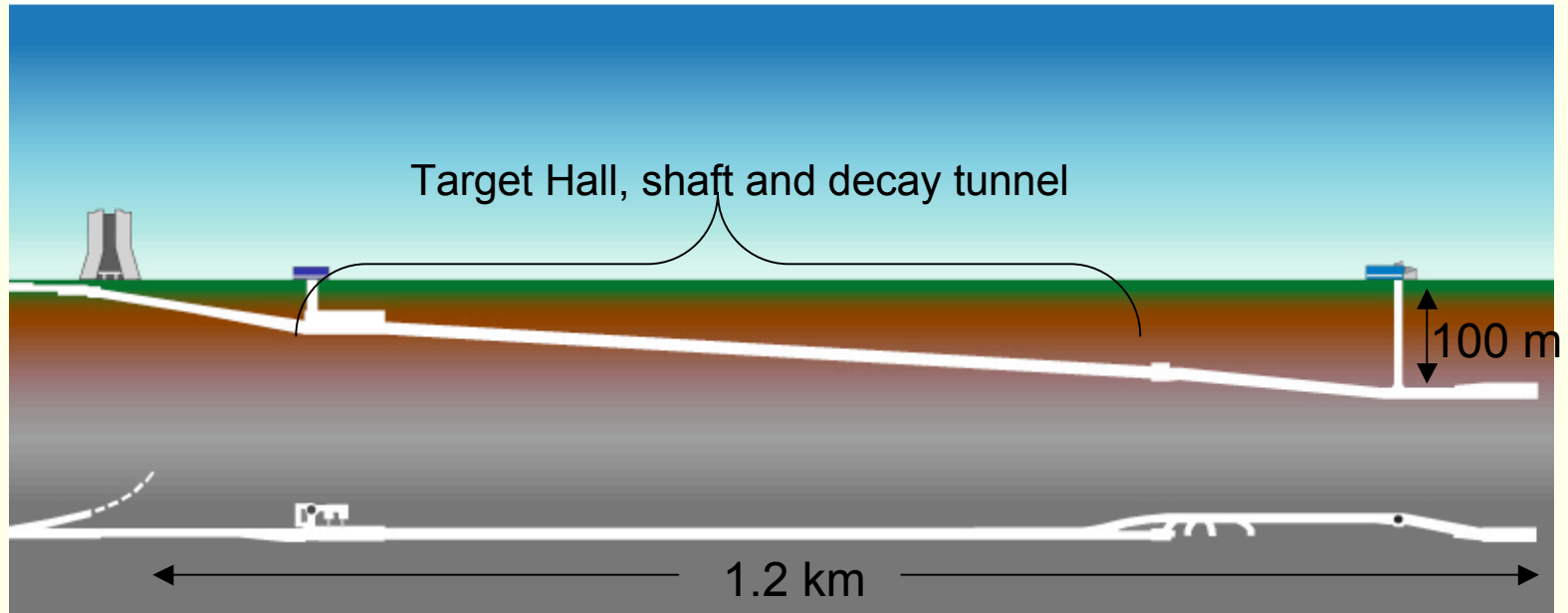
NuMI Civil Construction



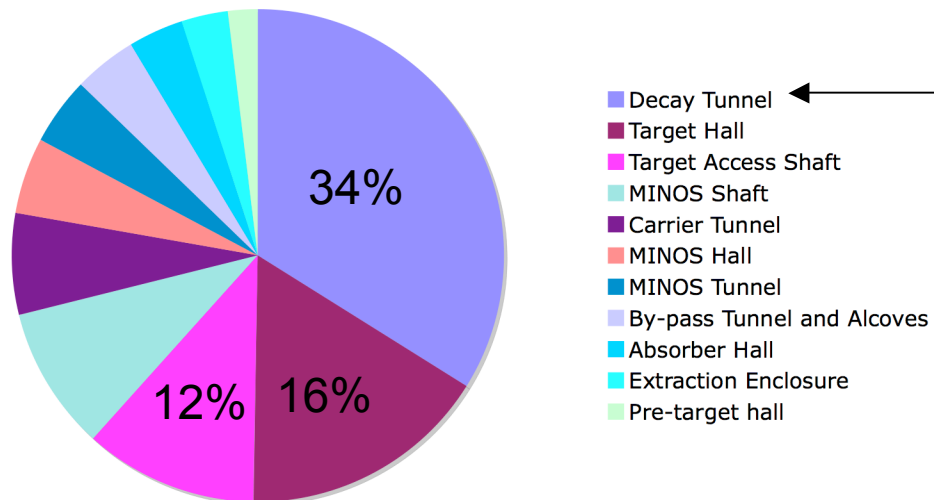
1.2	NuMI Civil Construction	ACWP (\$K)
1.2.1	Physics Design	70
1.2.2	Title I	1437
1.2.3	Title II	2974
1.2.4.2	Title III	6750
1.2.4.3	Site & Utilities	1094
1.2.4.4	Underground	40356
1.2.4.5	SB&O	17790
1.2.4.7	FNAL Procurement	421
	Total	59661
1.2.4.8.1	Const ES&H	753
1.2.4.8.2	Const FESS non-eng	333
1.2.4.8.3	Const UG Adv. Panel	1226
1.2.4.8.4	Const Misc	330
1.2.4.8.5	Const Pre-bid docs	1051
1.2.4.8		3693
1.2	Total	74585



Underground Cost Drivers

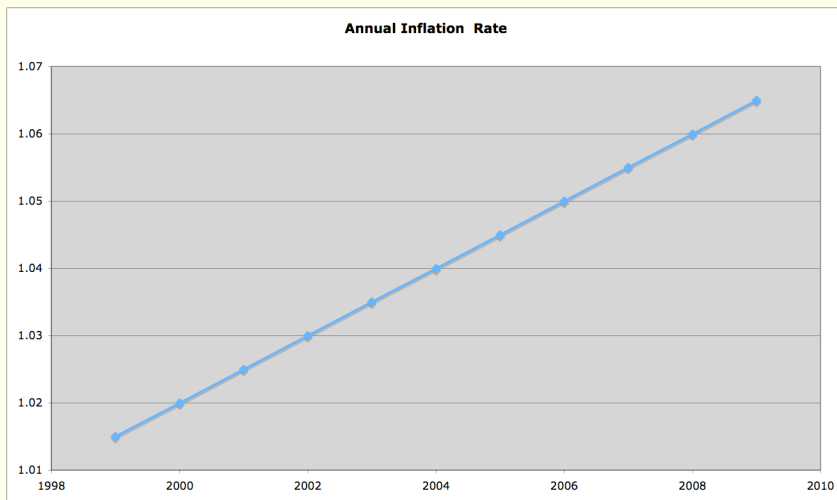
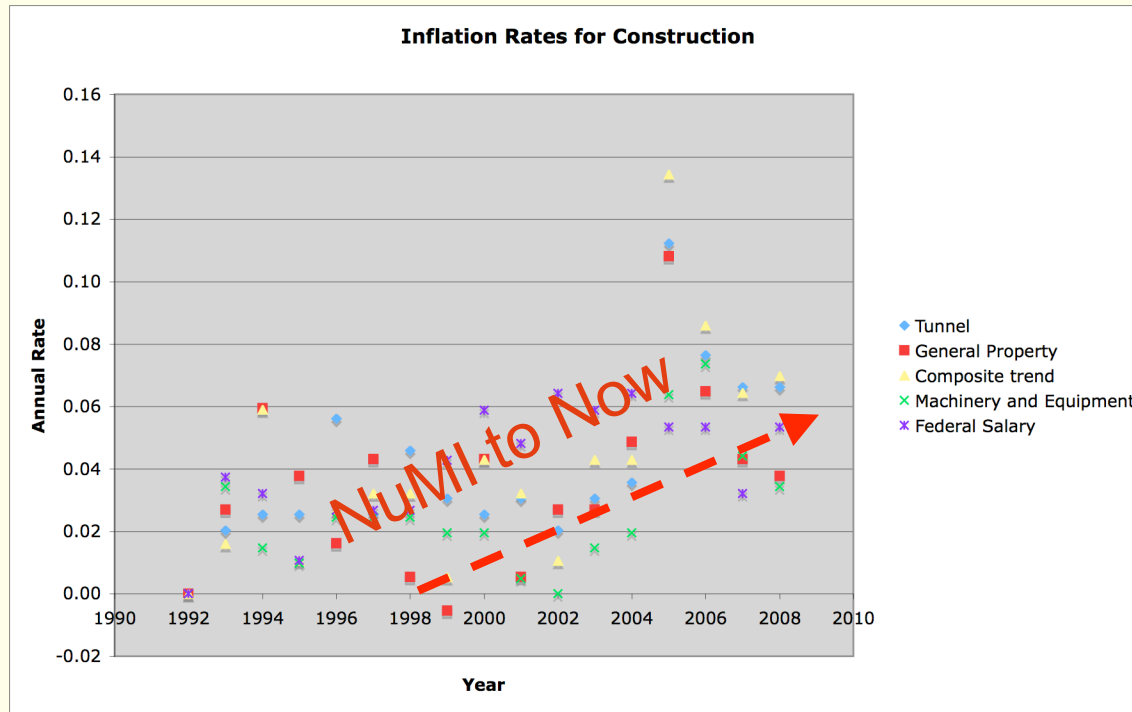


Underground contract : \$40 M

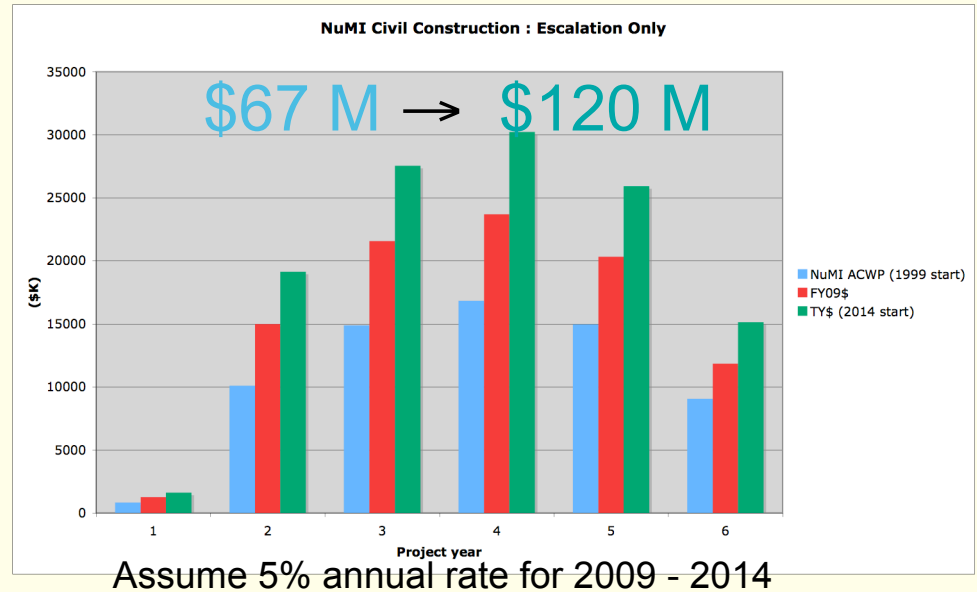


- Includes decay pipe and concrete shielding

What would NuMI (Civil) Cost to build now?



Estimate annual rate for 1998 - 2008 from chart
To get cost in FY09\$



What will be the major (civil construction) differences between NuMI and FeHo?

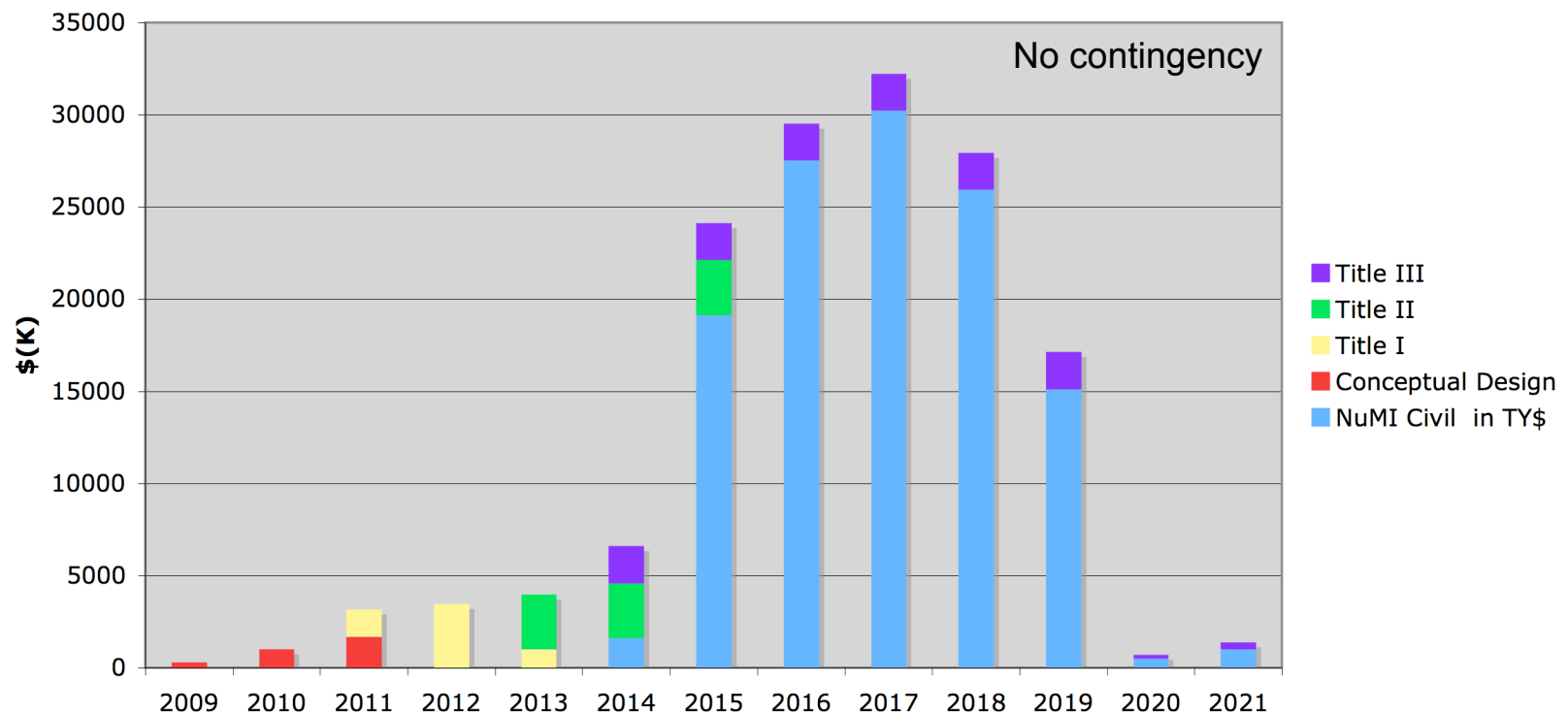
- Downward bend is 5.80° (NuMI is 3.3°)
 - Shafts will be deeper
- Decay pipe
 - 200 - 400 m length is being studied (NuMI is 675 m)
 - Width should be maximized : up to 4 meter diameter (NuMI is 2 m diameter)
- Shielding in target hall and decay tunnel
 - Needs to accommodate up to 2.3 MW beam power (NuMI can handle up to 700 kW after ANU)
- Near detector hall ???
 - By pass connection?
 - Beam monitoring?
 - Detector technology?

Optimizations which affect the civil construction need priority in the design effort

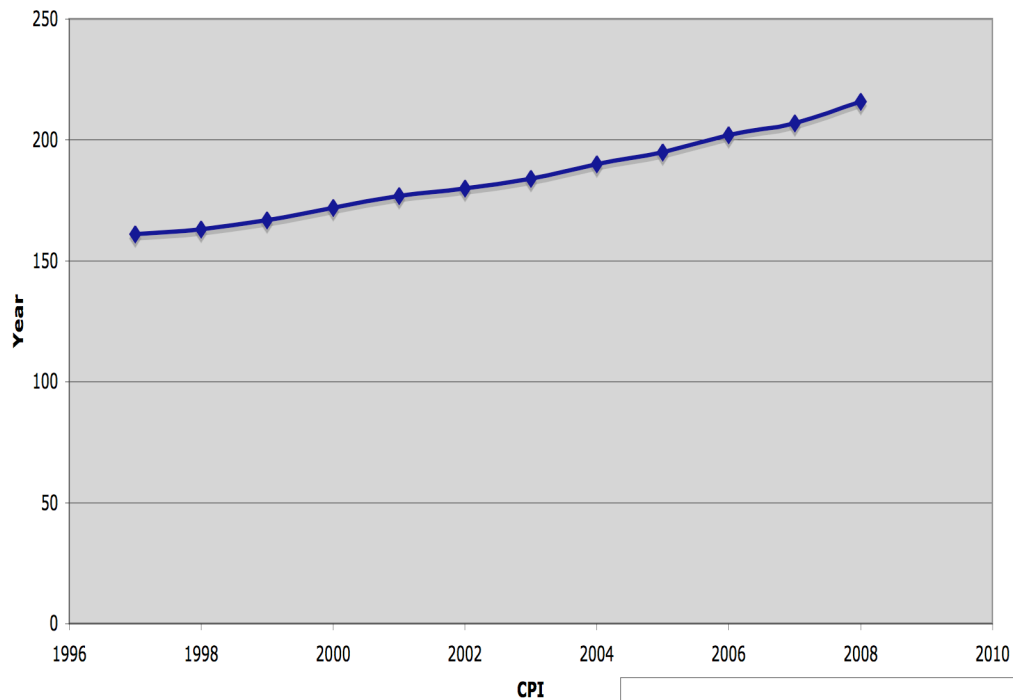
FeHo Civil Summary

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
NuMI Civil in TY\$						1616	19149	27550	30240	25946	15136	500	1000	121137
Conceptual Design	300	1000	1691											2992
Title I			1496	3487	1000									5982
Title II					2991	2991	2991							8973
Title III						1994	1994	1994	1994	1994	1994	200	400	12564
Subtotal	300	1000	3187	3487	3991	6601	24134	29544	32234	27940	17130	700	1400	151648
Contingency (50%)	150	500	1594	1744	1996	3301	12067	14772	16117	13970	8565	350	700	75824
Total	450	1500	4781	5231	5987	9902	36201	44316	48351	41910	25695	1050	2100	227472

FeHo Civil Construction Cost Profile

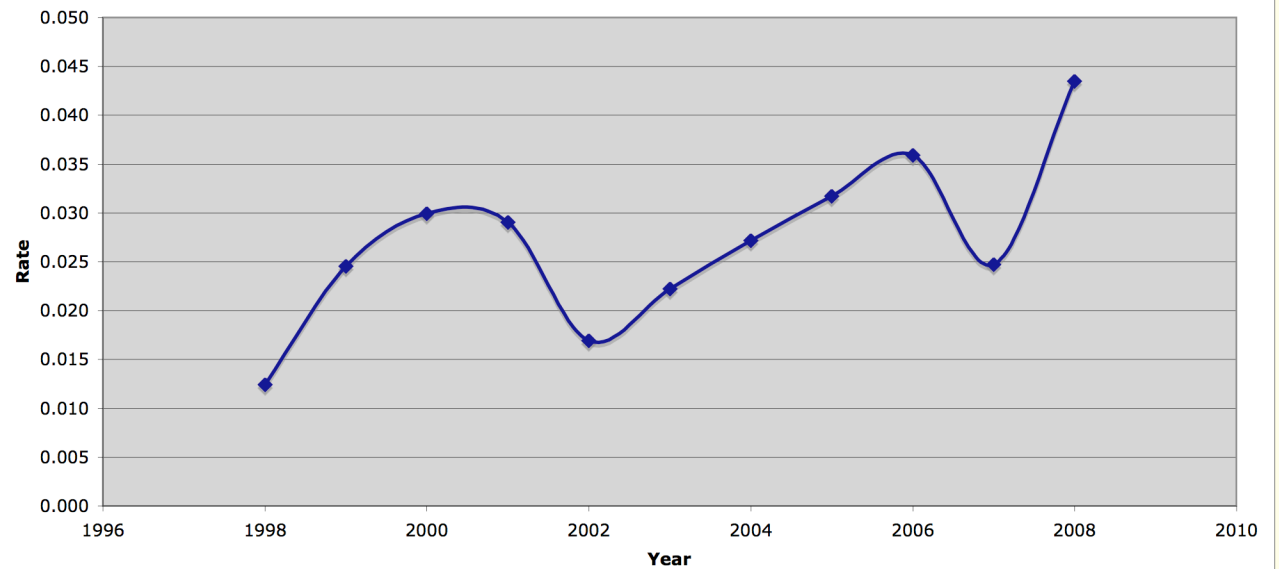


Consumer Price Index (1997-2008)



Input data for
Technical Component
inflation
calculation

Annual Inflation Rate (1998 - 2009)



Complexity factors

WBS	NuMI L3 System	SWF	M&S
1.1.1	Primary Beam	1.1	1.1
1.1.2	Neutrino Beam Devices	2.0	1.1
1.1.3	Power Supplies	1.1	1.1
1.1.4	Hadron Decay and Absorber	1.1	1.5
1.1.5	Neutrino Beam Monitoring	1.1	1.2
1.1.6	Alignment	1.1	1.1
1.1.7	Utilities	1.1	1.1
1.1.8	Installation and Infrastructure	1.1	1.3

1st “guesstimate” based on input from
“lessons learned” exercise;
I’ve been advised that these numbers are
TOO LOW.

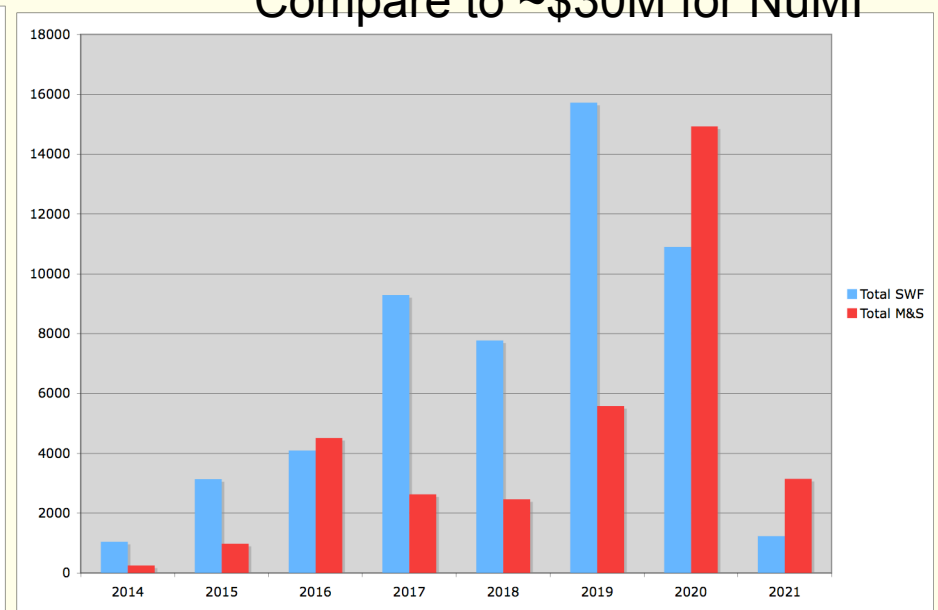
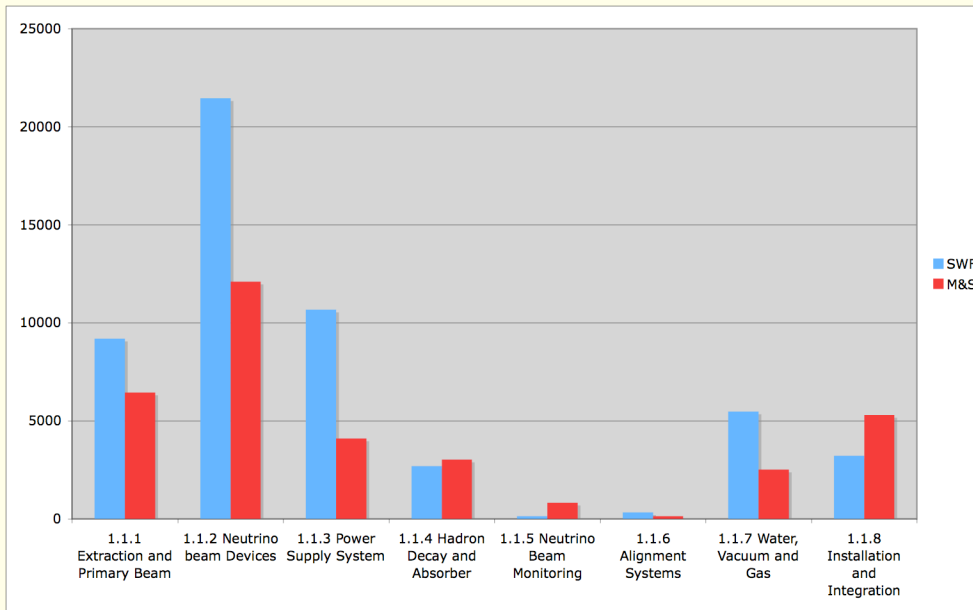
FeHo Technical Components

NuMI * Inflation * Complexity * Contingency (50%)

	SWF	M&S
1.1.1 Extraction and Primary Beam	9200	6456
1.1.2 Neutrino beam Devices	21459	12107
1.1.3 Power Supply System	10670	4113
1.1.4 Hadron Decay and Absorber	2702	3032
1.1.5 Neutrino Beam Monitoring	144	820
1.1.6 Alignment Systems	330	137
1.1.7 Water, Vacuum and Gas	5474	2516
1.1.8 Installation and Integration	3216	5307

	2014	2015	2016	2017	2018	2019	2020	2021	Total
Total SWF	1043	3141	4099	9286	7768	15725	10895	1237	53195
Total M&S	251	982	4508	2629	2462	5580	14929	3148	34489
Total	1293	4123	8608	11915	10230	21305	25825	4385	87684

Compare to ~\$30M for NuMI



Summary from NuMI Extrapolation

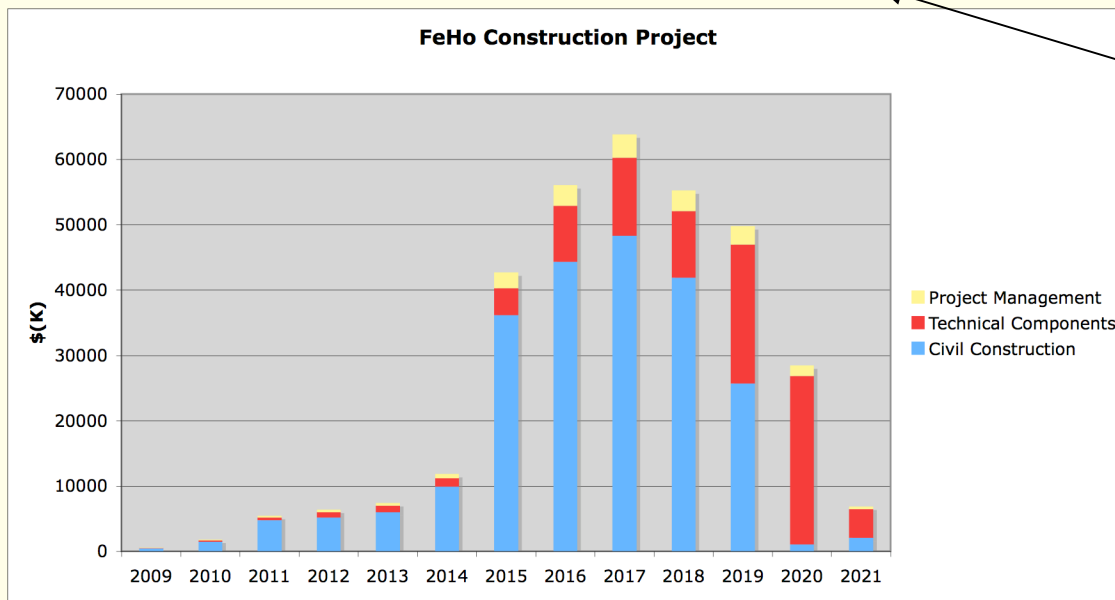
	Civil Construction	Technical Components	Project Management	Total
2009	450	100	33	583
2010	1500	200	102	1802
2011	4781	400	311	5492
2012	5231	800	362	6393
2013	5987	1000	419	7406
2014	9902	1293	672	11867
2015	36201	4123	2419	42743
2016	44316	8608	3175	56099
2017	48351	11915	3616	63882
2018	41910	10230	3128	55268
2019	25695	21305	2820	49820
2020	1050	25825	1613	28488
2021	2100	4385	389	6874
	227474	90184	19059	336717

Includes a modest ramp up in design work towards a 2014 construction start

Installation and tie in to existing NuMI carrier tunnel

6% (=2x NuMI; advised by OPMO that 10-15% is probably necessary these days)

Includes 50% contingency



Cost Range

- For CD-0 we need to give an “order of magnitude” cost range which they define as something like :
 - -50% to + 100%
 - Don’t yet know quite how to interpret this...
 - Work in progress : please don’t take the numbers too seriously

Decisions Needed

- Primary Beam Energy
 - 60 - 120 GeV is possible; choice affects the primary beam transport, beam losses, etc.
- Target-Horn configuration
 - Affects Target Hall dimensions; shielding arrangement....
- Decay Pipe Length and Radius
 - BIG impact : excavation and shielding
- Need for muon monitoring stations(?)
 - Prove they are needed or can be made to work
- Near Detector technology and size

High Priority Design Work

- Layout trajectory from NuMI thru ND
 - P. Lucas, G. Koizumi, S. Childress, C. Laughton
- Project Definition Report for tunnels, halls, SB&O (Needed for an updated cost estimate)
 - T. Lackowski (FESS) [\$30K]
 - Outsider A&E [~\$100K]
- Core samples (as many as we can afford!?) [~\$150k]
- Optimization - decay pipe, target/horns
 - M. Bishai
- Radiological calculations
 - B. Lundberg
- Target-horn design for 2.3 MW
 - FNAL AD, ANL, BNL, IHEP
 - Need to develop “Scopes of Work” for contributing groups
 - Real work requires real \$

FeHo Work Breakdown Structure Proposal

1.0	FeHo Beam Project
1.1	Civil Construction
1.1.1	Underground Construction
1.1.2	Underground Outfitting
1.1.3	Service Buildings and Outfitting
1.2	Technical Components
1.2.1	Primary Beam Transport
1.2.2	Neutrino Beam Devices
1.2.3	Decay Volume and Absorber
1.2.4	Radiological Shielding and Handling
1.2.5	Utilities
1.2.6	Integration
1.3	Project Management
1.3.1	FY - 1
...	
1.3.n	FY - n

Includes:
Power Supplies
Beam Monitoring

Does not include
shielding and remote
handling

New L3 system

Incorporates
Alignment

What makes up a Project Office/Team?

- **Project Scientist or Director**
- **Deputy Project Scientist or Director**
- **Project Manager**
- **Deputy Project Manager**
- **Control Account Managers (CAMs)**
- **Subproject Managers (i.e. Level 2)**
- **Subproject Leads (i.e. Level 3)**
- **Project Controls (Schedulers w/EVMS)**
- **Project Budget Manager/ Specialist Senior/Specialist**
- **Project Engineers (Mechanical, Electrical/ Electronics, Civil)**
- **System Integration Engineer**
- **Project Chemist**
- **Project Integration Manager**
- **Project Procurement Administrator/Specialist**
- **Project Risk Manager**
- **Project Configuration Manager**
- **Project Quality Manager**
- **Project ES&H**
- **NEPA Coordinator**
- **Project Webmaster**
- **Project Database Manager**
- **Project Administration**

Prepared by Fermilab OPMO, Dean Hoffer

Backup

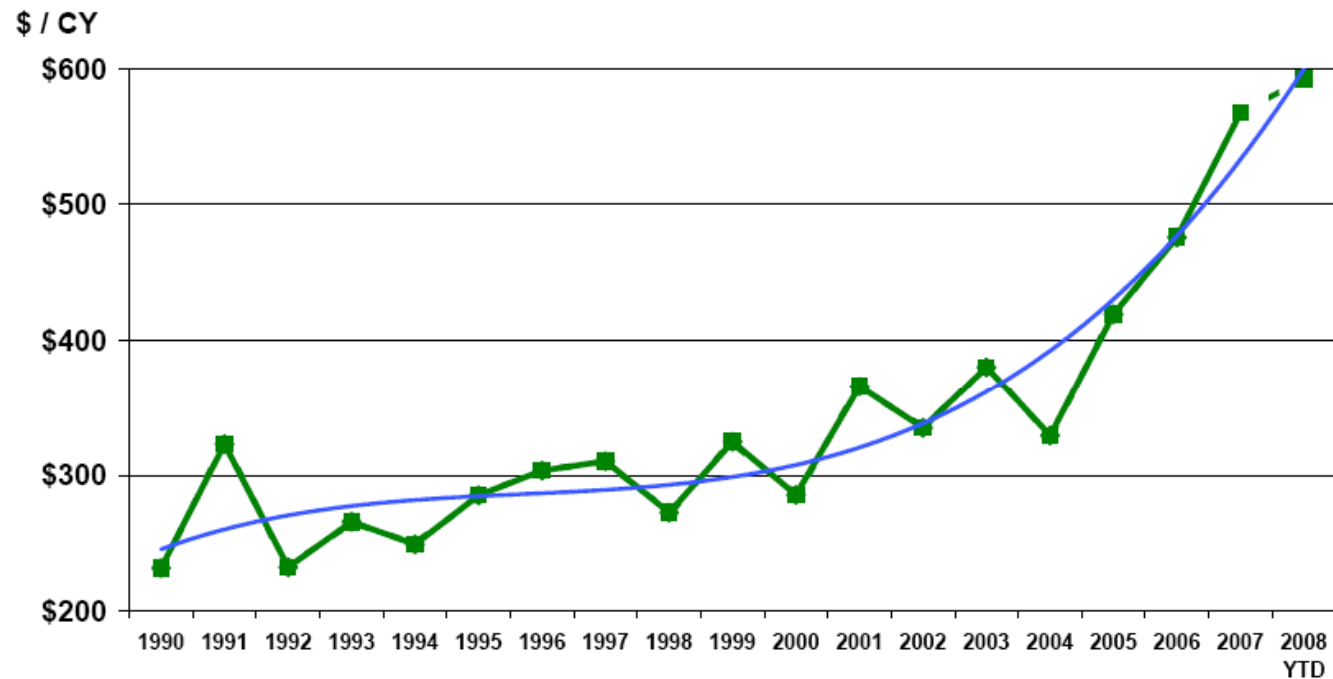
NuMI Civil Construction inflation calculation

NuMI Year		1999	2000	2001	2002	2003	2004	
	Annual Rate	836	10103	14899	16844	14958	9075	66715
1999	1.015							
2000	1.02	853						
2001	1.025	874	10356					
2002	1.03	900	10666	15346				
2003	1.035	932	11040	15883	17434			
2004	1.04	969	11481	16518	18131	15556		
2005	1.045	1013	11998	17262	18947	16256	9483	
2006	1.05	1063	12598	18125	19894	17069	9958	
2007	1.055	1122	13291	19122	20988	18008	10505	
2008	1.06	1189	14088	20269	22248	19088	11136	
2009	1.065	1266	15004	21586	23694	20329	11859	93739
Inflate +5 years	5%	1616	19149	27550	30240	25946	15136	119637

Construction Industry Escalation Data

STRUCTURAL CONCRETE

UNIT BID PRICE



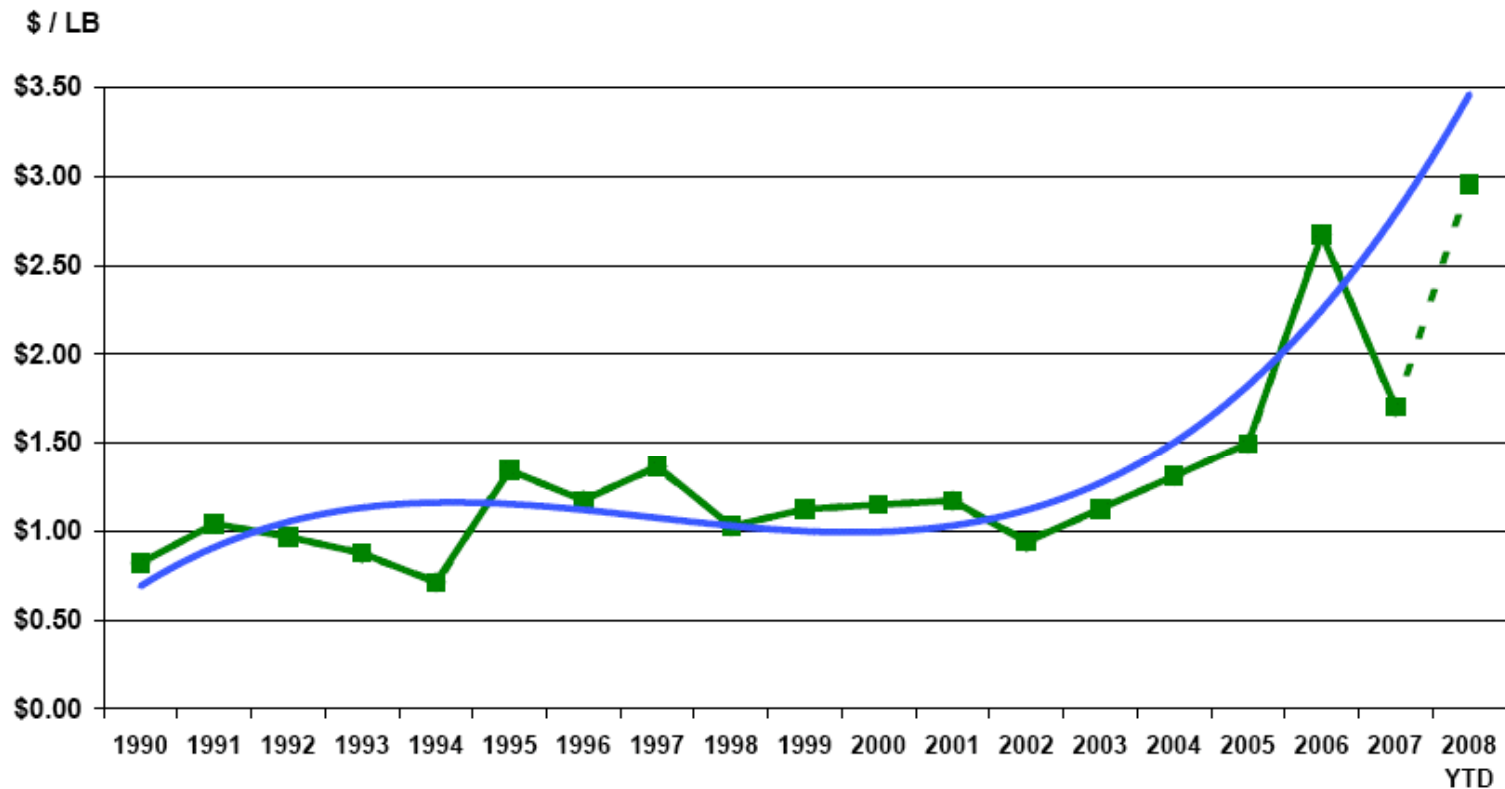
**Washington State
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For more information, please call the WSDOT Construction Office at (360) 705-7822
or visit <http://www.wsdot.wa.gov/biz/construction>

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STRUCTURAL STEEL

UNIT BID PRICE



**Washington State
Department of Transportation**

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